Four Corners Air Quality Group
Four Corners Area Current Studies
September 9, 2013

Ozone Studies

- Uintah Basin 2013 Winter Ozone Study
- Field campaign to measure and speciate VOCs at Navajo Lake and Bloomfield in 2004/2005 and 2009. A PowerPoint on the results is available on the Four Corners Air Quality website: http://www.nmenv.state.nm.us/aqb/4C/
- US Forest Service and Mountain Studies Institute started a monitoring program to look at foliar damage to sensitive plants from ozone at high altitude (2009), http://www.mountainstudies.org/Research/msiProjects.htm
    - Foliar ozone injury symptoms assessed and none found on ozone-sensitive plants in the San Juan Public Lands of SW CO: http://www.mountainstudies.org/sites/default/files/pdf/research/ozone/Ozone_Injury_Report_MSI_SJPLC_Nov09.pdf
- Annual Ozone Monitoring Results Report from Shamrock Monitoring Station (FS/BLM Southwest CO)
- New Mexico Environment Department has conducted ozone precursor and passive ozone sampling from 4/2009 – 10/2009 at Substation and Navajo Lake sites
- Mesa Verde National Park NPS ozone monitor conditions and trends tracked at http://www.nature.nps.gov/air/Monitoring/O3Plots/index.cfm
- Colorado State University is studying ozone impacts from oil and gas development quantifying the peak ozone impacts from oil and gas emissions in the western U.S., with a focus on Mesa Verde. A short paper has been written: http://www.cira.colostate.edu/publications/newsletter/spring2008.pdf
- Passive ozone study completed in Aug-Sept 2007 in SW Colorado.
- Ozone Precursors Emissions Inventory for San Juan and Rio Arriba Counties, New Mexico prepared for NMED by Environ (2006) http://www.nmenv.state.nm.us/aqb/projects/San_Juan_Ozone/NM_Area_Emissions_report.pdf, http://www.nmenv.state.nm.us/aqb/projects/San_Juan_Ozone/Errata_SanJuanRioArribaEI_0107.pdf
- Passive ozone study completed in San Juan County, New Mexico in 2004 and 2005 (with results used for locating the Navajo Lake monitor)
- Navajo Nation EPA Air Quality Control Program ozone monitoring in Shiprock with EPA data upload (AQS) since January 2010.

Mercury Studies

- Sather, M.E., Mukerjee, S., Smith, L., Mathew, J., Jackson, C., Callison, R., Scrapper, L., Hathcoat, A., Adam, J., Keese, D., Ketcher, P., Brunette, R., Karlstrom, J., Van der Jagt, G., 2013. Gaseous oxidized mercury dry deposition measurements in the Four Corners Area and Eastern Oklahoma, U.S.A. Atmospheric Pollution Research, doi: 10.5094/APR.2013.017. http://www.atmospolres.com/articles/Volume4/issue2/abstract5.htm .

- "Passive Monitoring of Ambient Reactive Gaseous Mercury in the Four Corners Area and Eastern Oklahoma" This presentation (available here: http://nadp.isws.illinois.edu/meetings/fall2010/post/session4.html) summarizes the first year of a two year air monitoring project estimating reactive gaseous mercury (RGM, a.k.a. gaseous oxidized mercury, GOM) dry deposition rates in the Four Corners area and eastern Oklahoma. The project collaborators include the U.S. Environmental Protection Agency (EPA) Region 6, EPA Office of Research and Development (ORD), Frontier Global Sciences, Alion, the New Mexico Environment Department (NMED), the National Park Service (NPS), the Bureau of Land Management (BLM), the Jemez Pueblo, and the Cherokee Nation.
- 2009- Passive Monitoring of Ambient Reactive Gaseous Mercury in the Four Corners Area and Eastern Oklahoma: http://nadp.isws.illinois.edu/meetings/fall2010/post/session4/Sather.pdf
- Mountain Studies Institute and the University of Colorado assessing soil mercury levels in burned vs. unburned areas of the park (ongoing study)
- Mountain Studies Institute (MSI) San Juan Mountains Mercury Studies: http://www.mountainstudies.org/index.php?q=content/air-quality-san-juan-mountains
    - Hows the Air Out There in English and Spanish - http://www.mountainstudies.org/sites/default/files/pdf/education/Air_Quality_Book_2009.pdf http://www.mountainstudies.org/sites/default/files/pdf/research/AirQualityForum/Como%20Esta%20El%20Aire%20Aqui.pdf
    - Bulk deposition collector at Molas Pass operating since April 2007, snowpack studies, and lake chemistry and biology study to determine mercury loading, report: http://www.mountainstudies.org/sites/default/files/pdf/research/mercury/Mercury_lakes_deposition_FINAL%20REPORT_1Sept2010%5B1%5D.pdf
    - 2009-2010 study of ecological effects and sources of mercury deposition at Mesa Verde, see report, http://www.mountainstudies.org/sites/default/files/pdf/research/mercury/HgMEVE2009_PilotHgeffects_FINALREPORT_30Aug2010%5B1%5D.pdf
        - & sampling fish and crayfish from the Mancos River in Mesa Verde
    - Report on sources of mercury deposition at Mesa Verde.
    - Back trajectory modeling of mercury deposition events at Mesa Verde and Molas Pass, Colorado, see report - http://www.mountainstudies.org/sites/default/files/pdf/research/mercury/Sources%20of%20Atmospheric%20Mercury%20Concentrations%20and%20Wet%20Deposition%20at%20Molas%20Pass%2C%20Southwestern%20Colorado.pdf
    - Collaborative project with CU Boulder to examine mercury fate and transport in terrestrial soils and reservoirs – see 2011 AGU Poster - http://www.mountainstudies.org/sites/default/files/pdf/research/mercury/Fate%20and%20Transport%20of%20Hg%20in%20the%20Four%20Corners%20Region.pdf
- Mercury Fingerprinting Study (University of Michigan study - in process). Research on fingerprinting mercury from different combustion sources in the atmosphere was

published in October 2008 Environmental Science and Technology Journal article "Mercury isotopes may put the finger on coal."

- Mesa Verde NPS Mercury Deposition Network (MDN) monitor. NADP-MDN website http://nadp.sws.uiuc.edu/mdn/ includes temporal trend graph for mercury. Total Hg in wet deposition has been monitored at Mesa Verde NP since 2002.
- San Juan Generating Station (SJGS) is studying the effects of using emissions control (baghouse and different types of activated carbon injection) on mercury emissions. SJGS is currently seeing greater than 90 percent removal efficiency for mercury with baghouses and activated carbon injection.
- Pine River Watershed Group has studied mercury in the Upper Pine River Watershed and Vallecito Reservoir in SW Colorado. The group measures mercury in precipitation at the Vallecito Reservoir.
- Dr. Richard Grossman has studied the concentration of Hg in human hair in Four Corners area.
- US Geological Survey (USGS) has measured Hg concentrations in snowpack at a few sites in the San Juan Mountains.

Multiple Pollutant and Other Deposition Studies

- West-wide Jumpstart Air Quality Modeling Study (WestJump) provides 2008 photochemical modeling input files to support future air quality planning in the western U.S., as well as modeling results for ozone and particulate matter that includes source apportionment. This work includes improved oil and gas emissions estimates for the major basins in the West, including the San Juan Basin and has just been completed this month and is available for comments and review until September 17, 2013. http://www.wrapair2.org/WestJumpAQMS.aspx

- The Three-State Air Quality Study in Colorado, Utah, and Wyoming, using the WestJump results as a starting point, will make further improvements to the 2008 base year modeling and generate a complete set of modeling inputs for 2011 to support future air quality planning work. Future year emissions estimates will also be developed. Photochemical modeling will be performed using these various 2011 and future year input files. The project is expected to be completed in Fall, 2014.

- BLM is currently conducting an air quality analysis with photochemical modeling for development, including oil and gas production, in Colorado. This comprehensive study is called CARMMs, and will be expanded this fall to include the Mancos Shale development in northwestern New Mexico. Modeling results should be available in 2014.

- Western Regional Air Partnership (WRAP) Oil and Gas Phase III inventory for the San Juan Basin was completed in 2009. http://www.wrapair2.org/PhaseIII.aspx
- “Detecting the Impacts of Nitrogen Pollution on Vegetation and Soils in Grand Canyon National Park.” Funded by NPS, Researchers from Northern Arizona University. Completed in 2013. Results from nitrogen isotope studies show that emission from vehicles in the park add excess nitrogen to pine trees near roadsides, and emissions from the Navajo Generating Station add excess nitrogen to plants and soils on the Paria

plateau. The study also found that it is feasible to continue work on remote sensing techniques that may be used in the future to assess nitrogen inputs to desert plants and soils.

- "Assessing the Risk of Nitrogen Deposition to Natural Resources in the Four Corners Region of Colorado and Utah." Funded by NPS. Researchers from USGS and Prescott College. NPS funded portion was completed in 2013, USGS work is ongoing. Results from the first phase of this study indicate that NOx represents a significant source of nitrogen deposition in Mesa Verde NP. Researchers are continuing to look at how excess nitrogen may be impacting cheat grass invasions in the area, using fertilization studies. Spatial and Seasonal Patterns and Temporal Variability of Haze and its Constituents in the United States: Report V June 2011. Hand et al., http://vista.cira.colostate.edu/IMPROVE/Publications/Reports/2011/2011.htm
- Apportionment of fine particulate carbon to biomass burning, vegetation, mobile, area and other sources at rural location throughout the United States including the Colorado Plateau
- Epidemiology Report on PM2.5 Exposure from Wildfires during 2011 Wallow Fire by the NM Department of Health http://www.arb.ca.gov/carpa/wallow-fire-smoke-exposures.pdf .
- Another peer reviewed paper related to our Four Corners Air Quality Task Force work has been published in the Journal of Environmental Monitoring, "Passive ammonia monitoring in the United States: Comparing three different sampling devices (November 2011)." Here is also a link to supplemental information on the study: http://www.nmenv.state.nm.us/aqb/4C/Documents/jemnov2011.pdf
- Beginning in 2010, the Southern Colorado Plateau Network (multi-park monitoring network) worked with Air Resources Division staff and EPA to sample waters for pesticides, pharmaceuticals and personal care products (PPCPs). Parks from the Four Corners area are included. Results will be reported in summer 2012 in SCPN's annual water quality summary report.
- National Forest Service Monitoring Activities
    - Ozone: Bayfield, CO (Shamrock site); Mesa Verde National Park; Coyote Ranger District, Santa Fe National Forest (early Summer 2012), Norwood, Colorado (installed 2010)
    - Mercury: Molas Pass, Mesa Verde National Park
    - Visibility: Engineer Mountain; Bayfield, CO (Shamrock site); San Pedro Parks, Santa Fe National Forest (early Summer 2012)
    - NOx – Shamrock, Bayfield Colorado
    - Atmospheric deposition/wilderness lake sampling
    - Wet/Dry Deposition: Mesa Verde National Park, Bayfield, CO (Shamrock site); Molas Pass; Wolf Creek Pass; San Pedro Parks Wilderness (Fall 2009)
    - NHx monitoring: Mesa Verde, CO, Bandelier, NM, Chiricahua, AZ
    - IMPROVE Speciated PM2.5 monitoring representative of all Class I areas
    - Mesa Verde National Park participates in a multi-agency dust monitoring network spread across the Colorado Plateau. Includes a webcam that records dust storms in the area. Impacts of recent, major dust deposition events include reduced visibility and the early onset of snowmelt. http://www.nps.gov/meve/naturescience/dustmonitoring.htm

- Throughfall/lichen monitoring for nitrogen, sulfur, & metals in northwest New Mexico on Carson and Santa Fe National Forest & potentially Mesa Verde (Fall 2013)
- Lichen monitoring (species and elemental analysis) through BYU at Wheeler Peak, San Pedro Parks, and Pecos Wilderness (Summer 2013-Summer 2014)
- Lichen monitoring through FIA in New Mexico (2010- preliminary data is now available)

- Los Alamos National Laboratories deployed a solar-tracking Fourier Transform Spectrometer (FTS) at the NM Substation site in 2011. The sunlight is focused inside the observatory into the FTS which splits the light into the spectral regions between the near infrared and ultraviolet to measure absorption features from atmospheric gases. Analysis of the spectra provides column measurements of all greenhouse gases (CO2, CH4 and N2O) and criteria pollutants (CO, NO2, O3, SO2) every 3 minutes.
  - Please contact the Principal Investigator of the Remote Sensing Verification Project (RSVP), Manvendra Dubey (dubey@lanl.gov), for technical information and Amon Haruta (amon@lanl.gov) for logistics and operations support.
- Navajo Nation EPA Air Quality Control Program monitoring activities:
  - Shiprock NO_2, SO_2, and ozone with EPA data upload (AQS) since January 2010
  - Shiprock PM_{10} data upload (AQS) since January 2000
  - Crownpoint PM_{10} data upload (AQS) since January 2007
  - Nazlini, AZ, $PM_{2.5}$ data upload (AQS) since January 2011
  - H_2S (suspended in July 2013) and ozone monitoring in Aneth, UT, since July 2012 in response to community concerns

- "Air Quality Modeling Study for the Four Corners Region," Revised Report August 2009 http://www.nmenv.state.nm.us/aqb/4C/Modeling.html
  - Detailed annual modeling of the Four Corners region for ozone and particulate matter impacts was conducted with updated emissions estimates for 2005, and a projected inventory for 2018. The resulting modeling database was used to examine the air quality impacts of five alternative mitigation scenarios focused on various combinations of emissions reductions from electric generating units (EGUs) and fuel combustion and evaporative sources associated with oil and gas exploration and production activities in the Four Corners region.
- Southern Ute Indian Tribe Air Quality Program
  - Maintains two air monitoring stations (Ute 1 and Ute 3) within the exterior boundaries of the Southern Ute Indian Reservation. Website: http://www.southernute-nsn.gov/air-quality/ambient-monitoring
  - Installed a Volatile Organic Compound (VOC) monitor as part of the EPA School Air Toxics Monitoring Pilot Project at Sunnyside Elementary School (2009). A copy of the final report conducted by the Southern Ute Indian Tribe on this short-term study can be found on EPA's School Air Toxics website at: http://www.epa.gov/schoolair/SunnysideE.html.
    Due to concerns of a sample taken by another organization, the Durango 9-R School District commissioned Walsh Environmental Scientists and Engineers, LLC to conduct an outdoor air quality evaluation at the Sunnyside Elementary

School in August 2011
http://www.durangoherald.com/article/20110830/NEWS01/708309941/-1/News
    - Collects visibility data at the Ute 3 station using a nephelometer and reporting to AQS since March 1, 2012.
    - Installed a continuous PM10 and PM2.5 particulate monitor at the Ute 3 station and reporting data to AQS since August 1, 2013.
- EPA Region 6 completed a passive ammonia study in 2007. A peer reviewed paper has been published in the Journal of Environmental Monitoring on "Baseline Ambient Gaseous Ammonia Concentrations in the Four Corners Area and Eastern Oklahoma, USA," September 25, 2008. Report available here: http://www.nmenv.state.nm.us/aqb/4C/Documents/Ogawa_Ammonia_4Corners_Sather_JEM08.pdf , The study was related to our Four Corners Air Quality Task Force work.
- EPA IMPROVE monitoring of aerosols for visibility continues at the Weminuche site north of Durango and at Mesa Verde. http://vista.cira.colostate.edu/improve/Default.htm
- Kirby Chapman, KSU, Oil and Gas Engine Control Studies: http://www.ngml.ksu.edu/
    - "Characterization of NSCR Performance on Four Stroke Natural Gas-Fueled Rich Burn Engines," October 2008.
- Mesa Verde NPS
    - National Atmospheric Deposition Program (NADP) monitor (NPS Air Resources Division's Government Performance and Results Act (GPRA) track conditions and trends) http://www.nature.nps.gov/air/who/npsPerfMeasures.cfm
    - Modeling simulations (CAMx) for total dry deposition in Mesa Verde. CASTNet only measures nitric acid, PM ammonium and PM nitrate. Modeling will estimate NH3, NO3 radical and organic nitrates to get a total dry deposition. (Analysis by Fall 2009)
- FS has funded several nitrogen deposition studies over the past 15 years (ongoing long-term commitment)
    - Full analysis of existing Wilderness Lakes data, including spatial and temporal trends and correlation of measurements with watershed and lake characteristics, completed by USFS up to 2004
    - High Lake Deposition Studies, NADP Program; Research results in: Musselman, R.C. and W. L. Slauson, 2004. Water chemistry of high elevation lakes in Colorado. Biogeochemistry 71:387-414. Also see: NADP 2006 Summary at http://nadp.sws.uiuc.edu/lib/data/2006as.pdf
    - FS/USGS High Alpine Snow Pack Studies (ongoing) at http://pubs.usgs.gov/fs/FS-043-97/
    - Atmospheric deposition/wilderness lake sampling
- Chronic Respiratory Study (NM Health Dept, "The Association between Ambient Air Quality Ozone levels and Medical Visits for San Juan County (2007) http://www.nmenv.state.nm.us/aqb/4C/Documents/SanJuanAsthmaDocBW.pdf
- Some trends research work done by Dr. Winn Wright and the Pine River Watershed Group (Vallecito Reservoir)